CLAIMS

What is claimed is:

1. A data storage device comprising:

a magnetic film;

at least one writing element comprising a track disposed in proximity to the magnetic film; and

wherein a data bit is selectively writable into a data region of the magnetic film, using a fringing field from a magnetic domain wall in the track to selectively change a direction of a magnetic moment in the data region.

2. The data storage device of claim 1, wherein the at least one writing element comprises an upper track disposed above the magnetic film and a lower track disposed below the magnetic film.

3. The data storage device of claim 2, wherein a data bit is selectively writable into a data region of the magnetic film where the upper track and the lower track cross, using fringing fields from magnetic domain walls in the upper track and the lower track.

4. The data storage device of claim 2, wherein the at least one writing element comprises an upper track and a plurality of lower tracks.

5. The data storage device of claim 4, wherein each of the upper track and the plurality of lower tracks comprises an individual magnetic wire.

6. The data storage device of claim 5, wherein the upper track and the plurality of lower tracks define a plurality of selectable data regions within the magnetic film.

7. The data storage device of claim 2, wherein the at least one writing element comprises a plurality of upper tracks and a lower track.

8. The data storage device of claim 7, wherein each of the plurality of upper tracks and the lower track comprises an individual magnetic wire.

9. The data storage device of claim 8, wherein the plurality of upper tracks and the lower track define a plurality of selectable data regions within the magnetic film.

10. The data storage device of claim 2, wherein the at least one writing element comprises a plurality of upper tracks and a plurality of lower tracks.

11. The data storage device of claim 10, wherein each of the plurality of upper tracks and the plurality of lower tracks comprises an individual magnetic wire.

12. The data storage device of claim 11, wherein the plurality of upper tracks and the plurality of lower tracks define a plurality of selectable data regions on the magnetic film.

13. The data storage device of claim 2, wherein the upper track comprises a bend;

wherein the lower track comprises a bend; and

wherein the data region corresponds to a region of the magnetic film where the bend of the upper track and the bend of the lower track cross.

14. The data storage device of claim 2, wherein the magnetic film is continuous.

15. The data storage device of claim 14, wherein the magnetic film is unstructured so as to render the location of the data bit non-localized.

16. The data storage device of claim 2, wherein the magnetic film comprises a single magnetic layer.

17. The data storage device of claim 2, wherein the magnetic film comprises a plurality of superimposed magnetic layers.

18. The data storage device of claim 17, wherein at least some of the plurality of superimposed magnetic layers are separated by at least one non-ferromagnetic layer.

19. The data storage device of claim 3, wherein the fringing fields from the magnetic domain walls in the upper and lower tracks are coincidentally moved toward the magnetic film to change a direction of a magnetic moment in the data region, effectively writing the data bit to the magnetic film.

20. The data storage device of claim 19, wherein the magnetic domain walls are moved by passing a writing current in at least one of the upper track and the lower track.

21. The data storage device of claim 20, wherein the data is binary and comprises a first state and a second state;

wherein the data bit assumes the first state in response to the current being passed in a first direction; and

wherein the data bit assumes the second state in response to the writing current being passed in a second direction.

22. The data storage device of claim 3, wherein the magnetic domain walls of the upper and lower tracks define a plurality of domains; and

wherein in a quiescent state, the domains are parked away from a data storage region of the magnetic film so that the fringing fields do not influence a state of the data region.

23. The data storage device of claim 3, wherein the plurality of upper tracks are connected together in series so that domain walls associated with magnetic regions defined by the magnetic domain walls are moved together across the data storage region.

24. The data storage device of claim 2, wherein the upper track comprises a block of magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material;

wherein the lower track comprises a block of magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material; and

wherein the data region corresponds to a region of the magnetic film where the block of the upper track and the block of the lower track cross.

25. The data storage device of claim 2, wherein the magnetic film is unpatterned.

26. The data storage device of claim 2, wherein the at least one writing element comprises homogeneous magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material.

27. The data storage device of claim 2, wherein the at least one writing element comprises inhomogeneous magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material.

28. The data storage device of claim 2, wherein at least one of the upper track or the lower track is constructed of alternating types of magnetic materials selected from the group consisting of ferromagnetic material and ferrimagnetic material.

29. The data storage device of claim 3, wherein the magnetic domain walls in at least one of the upper track and the lower track are pinned.

30. The data storage device of claim 29, wherein the magnetic domain walls in at least one of the upper track and the lower track are pinned by indentations in the at least one of the upper track and the lower track.

31. The data storage device of claim 2, wherein the magnetic film comprises an upper surface and a lower surface; and

further comprising an insulating tunnel barrier layer that overlies at least one of the upper and lower surfaces of the magnetic film.

32. The data storage device of claim 2, wherein the data bit that is written in the data region is read by passing a reading current from the upper track to the lower track that coincides with the data region.

33. The data storage device of claim 32, wherein the data bit is read by measuring a magnetic direction of the data bit.

34. The data storage device of claim 33, wherein a first magnetic direction of the data bit is indicative of a first resistance value of the tunnel junction.

35. The data storage device of claim 33, wherein a second magnetic direction of the data bit is indicative of a second resistance value of the tunnel junction.

36. The data storage device of claim 33, wherein the first resistance value of the tunnel junction is lower than the second resistance value of the tunnel junction.

37. The data storage device of claim 2, wherein the data bit that is written in the data region is read by passing a reading current in only one of any of the upper track or the lower track that crosses with the data region.

38. The data storage device of claim 37, wherein the data bit is read by measuring a change in resistance of the magnetic tunnel junction surrounding the insulating tunnel barrier layer.

39. The data storage device of claim 2, wherein the upper and lower tracks are disposed at an angle relative to each other.

40. The data storage device of claim 2, wherein the upper and lower tracks are disposed at a right angle relative to each other.

41. The data storage device of claim 1, wherein the magnetic film is patterned.

42. The data storage device of claim 41, wherein the patterned magnetic film comprises a plurality of patterned magnetic sections.

43. The data storage device of claim 42, further comprising an insulating layer that overlies at least one side of the patterned magnetic film.

44. The data storage device of claim 43, wherein the insulating layer is patterned into a plurality of patterned insulation sections.

45. The data storage device of claim 44, wherein the plurality of patterned magnetic sections cross with the plurality of patterned insulation sections.

46. The data storage device of claim 42, wherein each of the plurality of patterned magnetic sections stores at least one data bit.

47. The data storage device of claim 42, wherein the plurality of patterned magnetic sections are similarly shaped.

48. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are non-similarly shaped.

49. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are circularly shaped.

50. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are rectangularly shaped.

51. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are square shaped.

52. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are elliptically shaped.

53. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are triangularly shaped.

54. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are patterned into a plurality of rows.

55. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are patterned into a plurality of columns.

56. The data storage device of claim 42, wherein at least some of the plurality of patterned magnetic sections are patterned into a plurality of rows and a plurality of columns.

57. The data storage device of claim 1, further comprising a switch connected to the track, to pass current through the track for the purpose of writing the data bit.

58. The data storage device of claim 57, wherein the switch comprises a transistor.

59. The data storage device of claim 1, further comprising an insulating tunnel barrier layer disposed in proximity to the magnetic film.

60. The data storage device of claim 59, wherein the insulating tunnel barrier layer and the magnetic film form a tunnel junction.

61. The data storage device of claim 1, wherein the track comprises a bend.

62. The data storage device of claim 1, wherein the magnetic film is continuous.

63. The data storage device of claim 1, wherein the magnetic film is unstructured so as to render the location of the data bit non-localized.

64. The data storage device of claim 1, wherein the magnetic film comprises a single magnetic layer.

65. The data storage device of claim 1, wherein the magnetic film comprises a plurality of superimposed magnetic layers.

66. The data storage device of claim 65, wherein at least some of the plurality of superimposed magnetic layers are separated by at least one non-ferromagnetic layer.

67. The data storage device of claim 1, wherein the magnetic film is unpatterned.

68. The data storage device of claim 1, wherein the at least one writing element comprises homogeneous magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material.

69. The data storage device of claim 1, wherein the at least one writing element comprises inhomogeneous magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material.

70. The data storage device of claim 1, wherein the magnetic domain wall is shiftable.

71. A method of making a data storage device, comprising:

forming a magnetic film;

forming at least one writing element by disposing a track in proximity to the magnetic film;

wherein a data bit is selectively writable into a data region of the magnetic film, using a fringing field from a magnetic domain wall in the track to selectively change a direction of a magnetic moment in a storage region within the track.

72. The method of claim 71, wherein forming the at least one writing element comprises:

forming an upper track above the magnetic film; and

forming a lower track below the magnetic film.

73. The method of claim 72, wherein a data bit is selectively writable into a data region of the magnetic film where the upper track and the lower track cross, using fringing fields from magnetic domain walls in the upper track and the lower track.

74. The method of claim 72, wherein the at least one writing element comprises a plurality of upper tracks and a plurality of lower tracks.

75. The method of claim 74, wherein each of the plurality of upper tracks and the plurality of lower tracks comprises an individual magnetic wire.

76. The method of claim 72, wherein forming the upper track comprises forming a bend;

wherein forming the lower track comprises forming a bend; and

wherein the data region corresponds to a region of the magnetic film where the bend of the upper track and the bend of the lower track cross.

77. The method of claim 72, wherein forming the magnetic film comprises forming a continuous magnetic film.

78. The method of claim 71, wherein forming the magnetic film comprises forming an unstructured magnetic film so as to render the location of the data bit non-localized.

79. The method of claim 71, wherein forming the magnetic film comprises forming a single magnetic layer.

80. The method of claim 71, wherein forming the magnetic film comprises forming a plurality of superimposed magnetic layers; and

wherein at least some of the superimposed magnetic layers are separated by at least one insulating layer.

81. The method of claim 72, wherein forming the upper track comprises forming a block of magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material;

wherein forming the lower track comprises forming a block of magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material; and

wherein the data region corresponds to a region of the magnetic film where the block of the upper track and the block of the lower track cross.

82. The method of claim 71, wherein forming the magnetic film comprises forming an unpatterned magnetic film.

83. The method of claim 71, wherein forming the at least one writing element comprises using homogeneous magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material.

84. The method of claim 71, wherein forming the at least one writing element comprises using inhomogeneous magnetic material selected from the group consisting of ferromagnetic material and ferrimagnetic material.

85. The method of claim 72, wherein forming the upper track and the lower track comprises forming at least one of the upper track or the lower track of alternating types of magnetic materials selected from the group consisting of ferromagnetic material and ferrimagnetic material.

86. The method of claim 73, wherein forming the upper track comprises pinning the magnetic domain walls in the upper track.

87. The method of claim 73, wherein forming the lower track comprises pinning the magnetic domain walls in the lower track.

88. The method of claim 72, wherein the magnetic film comprises an upper surface and a lower surface; and

further comprising forming an insulating tunnel barrier layer that coats both the upper and lower surfaces of the magnetic film.

89. The method of claim 71, wherein forming the magnetic film comprises patterning the magnetic film.

90. The method of claim 89, wherein the patterned magnetic film comprises a plurality of patterned magnetic sections.

91. The data storage device of claim 71, further comprising overlying an insulating layer on one side of the track.

92. The method of claim 91, wherein overlying the insulating layer comprises patterning the insulating layer into a plurality of patterned insulation sections.

93. The method of claim 92, wherein the plurality of patterned magnetic sections cross with the plurality of patterned insulation sections.

94. The method of claim 90, wherein each of the plurality of patterned magnetic sections stores at least one data bit.

95. The method of claim 90, wherein the plurality of patterned magnetic sections are similarly shaped.

96. The method of claim 90, wherein patterning the plurality of patterned magnetic sections comprises patterning at least some of the plurality of patterned magnetic sections into non-similarly shaped magnetic sections.

97. The method of claim 90, wherein patterning the plurality of patterned magnetic sections comprises patterning at least some of the plurality of patterned magnetic sections into circularly shaped magnetic sections.

98. The method of claim 90, wherein patterning the plurality of patterned magnetic sections comprises patterning at least some of the plurality of patterned magnetic sections into rectangularly shaped magnetic sections.

99. The method of claim 90, wherein patterning the plurality of patterned magnetic sections comprises patterning at least some of the plurality of patterned magnetic sections into a plurality of rows.

100. The method of claim 90, wherein patterning the plurality of patterned magnetic sections comprises patterning at least some of the plurality of patterned magnetic sections into a plurality of columns.

101. The method of claim 90, wherein patterning the plurality of patterned magnetic sections comprises patterning at least some of the plurality of patterned magnetic sections into a plurality of rows and a plurality of columns.

102. The method of claim 71, further comprising connecting a switch to the track, to pass current through the track for the purpose of writing the data bit.

103. The method of claim 102, wherein the switch comprises a transistor.

104. The method of claim 71, further comprising forming an insulating tunnel barrier layer in proximity to the magnetic film.

105. The method of claim 105, wherein the insulating tunnel barrier layer and the magnetic film form a tunnel junction.

106. A method of writing a data bit on a data storage device that comprises a magnetic film; and at least one writing element disposed in a track in proximity to the magnetic film, the method comprising:

selectively writing the data bit into a data region of the magnetic film using a fringing field from a magnetic domain wall in the track to selectively change a direction of a magnetic moment in a storage region within the track.

107. The method of claim 106, further comprising connecting a switch to the track, to pass current through the track for the purpose of writing the data bit.

108. The method of claim 106, wherein the magnetic film is unpatterned.

109. The method of claim 106, wherein the track comprises an individual magnetic wire.

110. The method of claim 109, wherein the track defines a plurality of selectable data regions on the magnetic film.

111. The method of claim 106, wherein the magnetic film is continuous.

112. The method of claim 111, wherein the magnetic film is unstructured so as to render the location of the data bit non-localized.

113. The method of claim 106, wherein selectively writing the data bit comprises coincidentally moving the fringing field from the magnetic domain wall in the track toward the magnetic film to change a direction of a magnetic moment in the data region.

114. The method of claim 113, wherein coincidentally moving the fringing field from the magnetic domain wall in the track comprising passing a writing current in the track.

115. The method of claim 114, wherein passing the current in a first direction causes the data bit to assume a first binary state; and

wherein passing the current in a second direction causes the data bit to assume a second binary state.

116. The method of claim 106, further comprising pinning the magnetic domain wall in the track.

117. The method of claim 106, further comprising selectively reading the data bit in the data region by passing a reading current in the track that crosses with the data region.

118. The method of claim 117, wherein selectively reading the data comprises measuring a change in resistance of the insulating tunnel barrier layer.

119. A method of reading a data bit on a data storage device, comprising:

the data storage device being formed by disposing a tunnel junction that is comprised of an insulating tunnel barrier layer, in proximity to a magnetic film; and

selectively reading the data bit stored in a data region of the magnetic film by passing a reading current in the track that crosses with the data region.

120. The method of claim 119, wherein selectively reading the data bit comprises measuring a change in resistance of the insulating tunnel barrier layer.

121. The method of claim 119, wherein the magnetic film is unpatterned.

122. The method of claim 119, wherein the track comprises an individual magnetic wire.

123. The method of claim 122, wherein the track defines a plurality of selectable data regions on the magnetic film.

124. The method of claim 119, wherein the magnetic film is continuous.

125. The method of claim 124, wherein the magnetic film is unstructured so as to render the location of the data bit non-localized.

126. An apparatus for reading a data bit on a data storage device, comprising:

a tunnel junction formed by disposing an insulating tunnel barrier layer in proximity to a magnetic film;

a reading element that selectively reads the data bit stored in a data region of the magnetic film, by passing a reading current in the tunnel junction through the data region.

127. The apparatus of claim 126, wherein the reading element selectively reads the data by measuring a change in resistance of the insulating tunnel barrier layer.

128. The apparatus of claim 126, wherein the magnetic film is unpatterned.

129. The apparatus of claim 126, wherein the magnetic film comprises an individual magnetic wire.

130. The apparatus of claim 129, wherein the individual magnetic wire defines a plurality of selectable data regions.

131. The apparatus of claim 126, wherein the magnetic film is continuous.

132. The apparatus of claim 131, wherein the magnetic film is unstructured so as to render the location of the data bit non-localized.